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THE INFLUENCE OF WEATHER ON THE TIME AVAILABLE FOR SPOON GASSING RABBITS

by

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Introduction

The Agricultural Science Service Laboratory at Worplesdon is examining problems encountered by farmers trying to control the European rabbit (ORYCTOLAGUS CUNICULUS) in areas of Norfolk, Northamptonshire and Oxfordshire. Background information on the wild rabbit is given in Appendix A. One of the main methods of control used by farmers is spoon gassing. This technique involves transferring a heaped tablespoon of powder from a container into a rabbit burrow where the powder reacts with moisture to evolve hydrogen cyanide gas. Burrow entrances are sealed and a lethal concentration of gas subsequently builds up. However, gassing powder should not be used in wet or windy weather as the user risks inhaling either evolved gas or airborne powder. The technique is clearly weather sensitive as soon as a container is opened and particularly during the transfer of powder to the burrow. With these weather restrictions in mind Worplesdon approached the Regional Meteorological Unit requesting data analyses for the time available to carry out spoon gassing in these three areas.

Methodology

Data from met. sites at Honington, Cardington and Boscombe Down respectively were taken to be representative of these three study areas and were analysed for the months October to April (rabbit control being restricted to overwinter months) for as many years as possible.

The limitations imposed by the weather will vary according to the field situation in which the technique is being used. Control carried out in open fields and exposed hedgerows, for example, is likely to be more weather sensitive than similar work being carried out within a woodland; the analysis took these factors into consideration.

1) Analysis of the Potential Number of Daylight Working Hours in an Area of Relatively Open Ground

This is a theoretical consideration and gives the maximum possible number of hours available for work to an operator concentrating solely on spoon gassing, and who is prepared to work every hour the weather conditions are suitable.

Criteria

Wet weather has been defined to be any hour when rain has fallen or when snow is lying on the ground (state of ground code 5-9 inclusive). Elementary studies in a turbulent wind flow over wooded ground have indicated that wind speeds greater than or equal to 10 knots at a height of 0.5 metres (ie the working level) are of sufficient magnitude to remove small amounts of powder from the spoon. Thus to allow a sufficient "safety margin" mean hourly wind speeds of 8 and 12 knots at 10 m (approx. 5 and 7 knots respectively at 0.5 m) have been taken to represent "ideal" and "practical" working conditions respectively. The 8 knot wind would allow an operator to use heaped spoonfuls of powder with virtually no risk of inhaling the powder while the 12 knot wind speed applies more to the operator who is prepared to take risks in order to get the job done within the time available.

A potential working hour is defined as one with:

a) no precipitation
b) mean hourly wind speed at 10 m $\leqslant$8 or 12 knots
c) no snow or melting snow lying on the ground

An hourly frequency program was run for the months October to April for Boscombe Down (1969-78), Honington (1969-78) and Cardington (1971-78). Unfortunately hourly values of state of ground were not available and were omitted from the analysis. However observations at the synoptic hours were considered and interpolation used to try and determine a correction factor which could be applied to compensate for omission of state of ground from the analysis. Data for Boscombe Down revealed that over the ten years, 1969-78, a total error of approx. 2.5% had been introduced by omitting state of ground. However, most snow fell during a few months in 1969, 70, 71 and 78 so it was likely that a large error would result in these months. It was found that approximately ⅓rd of the hours unsuitable for work, because of snow lying, were also unsuitable for work because of strong winds or rainfall. It was decided therefore to deduct two hours instead of three, for each occasion when the ground was unsuitable.

The actual values, plus the percentage of the maximum possible, for the three sites are shown in Tables 1A - 1C. Figures 1A- 1G indicate the frequency with which limits of time available may be expected during the months October to April respectively. For example, figure 1A indicates that in 5 years out of 10, the monthly maximum possible time available for gassing in the open for a wind speed of 8 knots will be less than 163 hours during October, while 8 years out of 10 values of less than 190 hours can be expected. These figures can be expressed as a percentage of the max. possible by using the monthly daylight totals given under section 4. Figures 2A - 2C give the median and interquartile ranges (iqr's) of the potential time available for all three sites (figures are expressed as a % of the maximum possible).

2) Analysis of the Number of Half-Day Period available for Spoon Gassing along a woodland periphery by an Operator who bases his decision on a Met. Forecast

This study relates the time available for the small number of operators who contact their local forecast office each day to find out whether or not the weather will be conducive to work that day. It assumes that a period of three consecutive working hours is of sufficient duration to enable the operator to get out and do the job and that each period would have been correctly forecast. Being a practical analysis, the hour 1200-1300 GMT has been designated a lunch break and is not analysed.

Criteria

As work here is being carried out along a woodland periphery, the wind flow will have been reduced somewhat by the trees, allowing work to proceed under windier conditions than in the previous analysis.

A wind of 16 knots at 10 m (approx. 10 knots at 0.5 m) has been taken to represent working conditions, while a 20 knot wind (approx 12 knots at 0.5 m) applies to the operator who is prepared to take risks in order to get the job finished as soon as possible. The tree canopy (or hedgerow) will also afford limited protection against rainfall from certain directions, but is insufficient to prevent precipitation reaching the operator.

A half work day is defined as three consecutive hours with:

a) no precipitation
b) mean hourly wind speed at 10 m $\leq$ 16 or 20 knots
c) no snow or melting snow lying on the ground. Again interpolation was used and if snow was lying at two synoptic hours then it was assumed that snow was also lying for intermediate hours.

Data for Cardington were analysed (daylight hours) for the period 1971-78, each month being divided into two parts to enable the best half monthly period for spoon gassing to be determined while each day has been split into morning and afternoon, again to determine which is the most favourable time for gassing. For convenience, the average daylight period, rounded to the nearest hour, has been used (as given by Forsdyke in Ag. Mem 645). The actual values are shown in Table 2, while figure 3 shows an analysis of these results.

3) Analysis of the Number of Half-Day Periods available for spoon gassing along a woodland periphery by an Operator who does not rely on Met. Forecasts to plan his work

This study relates to the majority of operators, who tend to take little more than a passing interest in Met. forecasts, either because they think they know best or because of an unawareness of the services provided by the Met. Office. It basically assumes that the operator would make a subjective decision on work or no work first thing in the morning and afternoon, based on the weather situation at that time. In practice, if the operator had decided to work and the weather later deteriorated then it is likely that he would press on with the work to get it finished, regardless of the dangers involved.

Criteria

A computer program was run for Cardington 1971-78 to look at the hours 0800 and 1300 GMT each day for the months October - December, February-April, and the hours 0900 and 1300 GMT for January. The following criteria were looked at in the specified hours:

a) no precipitation
b) mean hourly wind speed at 10 m $\leq$16 or 20 knots
c) no snow or melting snow on the ground

If the observation at 0800 (or 0900) was conducive to work then the morning was classed as a half work day, and similarly for the 1300 observation.

Again the two critical wind speed values were used to make the results more applicable to a practical situation. The results are presented in Table 3, while figure 4 shows the median and i.q. range.

4) Analysis of the Potential Number of Working Hours within a Woodland

- a theoretical consideration giving the maximum number of hours available for work to the operator whose sole concern is spoon gassing.

Criteria

Previous analyses concerned themselves with work in exposed, or relatively exposed areas such as woodland periphery, hedges, fields etc., where most of the work will be carried out but where the weather is a critical factor. However, large rabbit infestations may be found in dense harbourage, where the tree canopy significantly reduces the wind flow and provides shelter from precipitation. The previous criteria would therefore be too stringent for gassing under such conditions, especially in practice where an operator may press on with the job even though the weather within the canopy is not really suitable.

In such circumstances, then, it is suggested that a working hour be defined as one with:

a) precipitation $\leq$ 1 mm
b) mean wind speed at 10 m $\leq$ 30 knots

The results for Cardington (1971-78) are given in Table 4.

NB. It should be noted, however, that the results in Table 4 appear to be inconsistent if the working hours are calculated as a percentage of the maximum possible. This is because the frequency analysis program includes in the observation, hours just before sunrise and hours just after sunset (if sunrise or sunset occurs almost on the hour). Thus the program will read more hourly observations than there are daylight hours, giving a slight error in the results. The actual monthly totals of daylight hours from which the percentages were calculated are given below:

Station	Oct	Nov	Dec	Jan	Feb	March	April
Cardington and Honington	335	267	242	254	274	366	414
Boscombe Down	335	270	240	260	277	366	414

Discussion

Figure 1B indicates that of the three sites considered, Cardington has the most time available for gassing in an area of relatively open ground due possibly to the enhanced rainfall at Boscombe and relatively severe winters at Honington (with many days of snow cover). For ideal gassing conditions (ie wind speeds $\leq$8 knots at 10 m), there is a median value of 25-50% at all three sites with an iqr of 5-60%; for 12 knot winds, the median value is 45-75% with an iqr of 35-85%. October is consistently the best month with high median values and relatively small iqr's, while December and January are much more variable. The above results are, of course, theoretical and give the maximum possible time available for gassing in the open. In practice therefore, one would expect the time available to be less depending upon under what conditions the operator is prepared to work. In the light of these results, spoon gassing in the open would appear to be severely restricted by the weather in the areas considered.

The practical considerations for working along a periphery (Figs 2 and 3) give a different picture however. These indicate that weather is not limiting with regularly over 20 morning and afternoons per month when work was possible (5 years in 10) although the 16 knot analysis tended to be much more variable than the 20 knot. Results suggest that October, December and mid-February to mid-March are the most favourable months for gassing while November and January to mid-February are less reliable. Fig 2 illustrates that the time available to an operator who uses met. forecasts is generally less than for the operator who makes his own subjective decision, and also tends to be more variable (as shown by the large iqr's in Fig 2). This is probably because although the weather may be limiting in some years to the operator who takes met advice, the majority of operators would make up this 'time deficit' by working under less than ideal conditions. From these results, one can safely assume that the weather is unlikely to impose severe time restrictions in most years along a woodland periphery in the counties considered.

The potential time available for work within a woodland is very high, indicating that the tree canopy reduces the effects of the weather to a great extent. On this basis then, time will not be limited by the weather within a woodland.

Conclusions

Future work might require analysis on a national basis; one would suggest, however, that the findings of this report could be applied to inland areas of south-east, central southern and eastern England where wind and rainfall regimes are fairly similar. It is likely, however, that rabbit control by spoon gassing in most other parts of the country will be more limited by weather than in the regions mentioned.

It is re-emphasised that this study only considered the effects of weather on the time available to carry out spoon gassing and makes no attempt to comment on the effectiveness of spoon gassing as a control technique once the powder has been placed in the burrows.

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APPENDIX A

BACKGROUND INFORMATION ON THE WILD RABBIT

The European Rabbit was introduced into England during the 11th or 12th Century and for many years was highly valued as a source of fresh meat and fur. Farmers, however, soon became aware of its destructiveness to crops and by the mid-19th Century the rabbit was recognised as the most destructive vertebrate pest of agriculture.

Rabbits prefer to live where there is harbourage, particularly in woodland, scrub and rough areas, especially if these are divided into small blocks with plenty of hedges adjacent to suitable food such as pasture, cereals and new forestry plantations. Such areas have the greatest density of rabbits, sometimes approaching pre-myxomatosis levels.

Description and Biology

Mature rabbits weigh between 1.5 and 2 kg and eat about 0.5 kg of green food a day, grazing for about eight hours or so at night.

Breeding starts towards the end of January and 95% of the does become pregnant. The gestation period varies from between 28 days to 30 days, and an average litter contains 3 to 6 young which are weaned and are capable of finding their own food after about 3-4 weeks. There is a succession of litters up until July, a single doe having up to 30 young, but on average about 20. This figure is higher than the pre-myxomatosis level when many does aborted or reabsorbed their young.

Myxomatosis

This is a virus disease affecting wild rabbits and their domesticated varieties. It is a mild disease of the native rabbits of southern North America, Central and South America, and was deliberately introduced into Australia during December 1950 for rabbit control purposes and then into France during 1952, finally reaching Britain in late summer 1953. The disease spread throughout Britain during 1954-55, killing an estimated 99% of the rabbit population. Since then, however, less virulent strains of the myxoma virus have become predominant in the field and the rabbit population has gradually increased, especially over the past 5-6 years. Numbers are unlikely to return to pre-myxomatosis levels, however, because:-

i) farmers today know what it is like to farm without rabbit problems and would be unwilling to accept the levels of damage which used to occur.

ii) with increased mechanisation, many hedges have been removed to make larger fields. Also, land which would previously have been left derelict is today being turned into fair agricultural land, due to the high value of land, so that rabbit cover is effectively reduced.

iii) On most sites myxomatosis is still present during the autumn period and occasionally for the whole year round. Most overwintering populations will be of rabbits which have contracted the disease, recovered and have acquired an immunity. The progeny of immune does themselves acquire a degree of immunity which lasts for two months or so. The first young rabbits of the year therefore become susceptible to the disease during April. The numbers of young build up later in the season and late-season young lose the maternal immunity in August and September. Myxomatosis can then spread rapidly killing many young during September to November.

Damage

Insects, poor seed, insufficient fertiliser and exhaustion of the land are often blamed for the apparent failure of a crop, but close inspection will often reveal that rabbit grazing is the cause of failure. Rabbits generally prefer wheat to oats, barley or rye and crops are reduced in varying degrees up to complete failure. Damage to grassland is often serious, with winter grazing seriously affecting grass growth in early spring; economic loss from rabbits is most keenly felt at this time of year. Foresters and fruit growers are similarly affected, necessitating the erection of expensive netting fences. As well as damaging trees, trees may be killed by ring barking and by eating seedlings, thus preventing natural regeneration.

A study of rabbit damage to winter wheat for 16 sites throughout the country indicated that there was an average reduction in yield, attributable to rabbit grazing, of 15.7% equivalent to 0.83t/ha. For price levels at the end of 1978, this would mean a financial loss of approximately £62/ha.

Rabbit Control

With an increase in rabbit numbers throughout the country, and a reduction in the overall effectiveness of myxomatosis, greater attention must be paid to rabbit control. A control program should be planned for the period November to March when harbourage is at a minimum and before the does breed and produce young.

The following methods of control are currently in use:-

I. Gassing

This method is humane and highly efficient under the right conditions. Essentially it involves driving underground, as many rabbits lying out as possible. The fumigant most extensively used in this country is 'Cymag' which appears in the form of a powdered cyanide compound which, in contact with moist air, evolves cyanide gas, from which death is rapid and relatively painless. There are three methods for administering the powder:-

i) Power Gassing

- more suitable for larger well-populated warrens, with many holes. The powder is blown into the burrow system by means of an engine-powered fan, cyanide gas is released and the burrows are filled with a lethal concentration.

ii) Hand-Operated Pump

- similar procedure to power gassing but is suitable only for small warren systems.

A moderate flow of air is advantageous in both of the above methods for distributing the gas throughout the warren. The disadvantage of these methods is that they are "labour intensive", requiring two or three people to carry out the job.

iii) Spoon Gassing

This is the most widely used method, requiring only one person. It is more economical for small infestations, and involves placing a sufficient amount (approx 28g) of powder into the burrow entrance with a tablespoon. A low wind speed is required for this operation to prevent the powder blowing off the spoon. The burrow is then sealed up with earth and a lethal concentration of cyanide builds up which usually kills the rabbits as they try to re-open the burrow entrance.

II. Other Methods

These include: trapping, shooting, ferreting, snaring, long netting, dazzling and fencing.

These methods produce carcasses, in contrast to gassing where the carcasses remain inaccessable underground, although they are generally less efficient than gassing.

TABLE 1 A

- the potential number of daylight hours during the month when gassing in an area of relatively open ground was possible; also expressed as a percentage of the maximum possible.

1) DATA FOR CARDINGTON

$\leqslant$ 8 knots

i) Actual hours

Year	Jan	Feb	Mar	Apr	Oct	Nov	Dec
1971	122	173	154	204	149	100	114
1972	102	120	170	117	169	97	100
1973	160	128	222	187	195	106	88
1974	61	123	210	218	140	89	13
1975	65	210	138	169	171	118	103
1976	33	113	118	160	147	126	94
1977	111	112	106	102	157	46	58
1978	47	63	70	121	192	90	49

ii) Percentage of max. possible

Year	Jan	Feb	Mar	Apr	Oct	Nov	Dec
1971	48	63	42	49	44	37	47
1972	40	44	46	28	50	36	41
1973	63	47	61	45	58	40	36
1974	24	45	57	53	42	33	5
1975	26	77	38	41	51	44	43
1976	13	41	32	39	44	47	39
1977	44	41	29	25	47	17	24
1978	19	23	19	29	57	34	20

TABLE 1A (Continued)

≤ 12 knots

i) Actual hours

Year	Jan	Feb	Mar	Apr	Oct	Nov	Dec
1971	164	215	242	316	218	174	166
1972	159	209	234	203	281	178	164
1973	224	183	304	292	268	178	154
1974	121	174	311	341	228	158	72
1975	131	250	253	295	255	186	163
1976	86	205	191	254	190	190	167
1977	204	165	197	192	231	107	152
1978	97	143	143	252	270	167	109

ii) Percentage of max. possible

Year	Jan	Feb	Mar	Apr	Oct	Nov	Dec
1971	65	78	66	76	65	65	69
1972	63	76	64	49	84	67	68
1973	88	67	83	71	80	67	64
1974	48	64	85	82	68	59	30
1975	52	91	69	71	76	70	67
1976	34	75	52	61	57	71	69
1977	80	60	54	46	69	40	63
1978	38	52	39	61	81	63	45

TABLE 1 B

2) DATA FOR HONINGTON

$\leq$8 knots

i) Actual Hours

Year	Jan	Feb	Mar	Apr	Oct	Nov	Dec
1969	← no data →				166	40	5
1970	85	0	19	102	120	74	18
1971	80	140	112	189	147	50	84
1972	88	79	138	75	149	101	90
1973	166	99	190	108	155	62	49
1974	52	94	146	142	88	68	6
1975	64	152	91	119	145	104	100
1976	0	69	75	160	154	112	107
1977	69	100	73	81	136	38	75
1978	46	0	61	137	188	67	8

ii) Percentage of max. possible

Year	Jan	Feb	Mar	Apr	Oct	Nov	Dec
1969	← no data →				50	15	2
1970	33	0	5	25	36	28	7
1971	31	51	31	46	44	19	35
1972	35	29	38	18	44	38	37
1973	65	36	52	26	46	23	20
1974	20	34	40	34	26	25	2
1975	25	55	25	29	43	40	41
1976	0	25	20	39	50	42	44
1977	27	36	20	20	41	14	31
1978	18	0	17	33	56	25	3

TABLE 1 B (continued)

≤12 knots

i) Actual Hours

Year	Jan	Feb	Mar	Apr	Oct	Nov	Dec
1969	← no data →				275	85	88
1970	146	49	111	202	191	138	91
1971	134	202	215	315	214	126	160
1972	144	166	223	179	266	171	163
1973	210	161	303	223	232	117	108
1974	96	147	257	280	173	130	48
1975	118	219	190	240	237	172	158
1976	46	152	176	268	178	164	159
1977	153	160	170	171	229	91	139
1978	98	59	131	262	254	130	66

ii) Percentage of max. possible

Year	Jan	Feb	Mar	Apr	Oct	Nov	Dec
1969	← no data →				82	32	36
1970	57	18	30	49	57	52	38
1971	53	74	59	76	64	47	66
1972	57	61	61	43	79	64	67
1973	83	59	83	54	69	44	45
1974	38	54	70	68	52	49	20
1975	46	80	52	58	71	64	65
1976	18	55	48	65	53	61	66
1977	60	58	46	41	68	34	57
1978	39	22	36	63	76	49	27

TABLE 1 C

3) DATA FOR BOSCOMBE DOWN

≤8 knots

i) Actual hours

Year	Jan	Feb	Mar	Apr	Oct	Nov	Dec
1969	23	100	115	116	150	40	21
1970	69	5	36	93	104	61	15
1971	32	135	98	126	116	93	98
1972	80	78	114	74	84	138	92
1973	133	110	197	113	133	99	87
1974	32	85	158	139	111	71	28
1975	57	78	34	142	139	102	157
1976	52	124	112	149	114	138	96
1977	93	64	68	110	106	65	62
1978	57	0	83	114	161	96	37

ii) Percentage of max. possible

Year	Jan	Feb	Mar	Apr	Oct	Nov	Dec
1969	9	36	31	28	45	15	9
1970	27	2	10	22	31	23	6
1971	12	49	27	30	35	34	41
1972	31	28	31	18	25	51	38
1973	51	40	54	27	40	37	36
1974	12	31	43	34	33	26	12
1975	22	28	9	34	41	38	65
1976	20	45	31	36	34	51	40
1977	36	23	19	27	32	24	26
1978	22	0	23	28	48	36	15

TABLE 1 C (continued)

⩽12 knots

i) Actual hours

Year	Jan	Feb	Mar	Apr	Oct	Nov	Dec
1969	84	166	209	214	260	112	74
1970	114	56	112	162	174	118	127
1971	99	187	216	244	210	153	184
1972	129	145	212	155	207	198	144
1973	200	175	297	242	219	164	137
1974	81	138	258	272	194	134	82
1975	103	173	165	246	258	180	199
1976	114	201	195	265	179	199	154
1977	137	127	169	225	213	146	127
1978	120	59	153	223	260	163	75

ii) Percentage of max. possible

Year	Jan	Feb	Mar	Apr	Oct	Nov	Dec
1969	32	60	57	52	78	41	31
1970	44	20	31	39	52	44	53
1971	38	68	59	59	63	57	77
1972	50	52	58	37	62	73	60
1973	77	63	81	58	65	61	57
1974	31	50	70	66	58	50	34
1975	40	62	45	59	77	67	83
1976	44	73	53	64	53	74	64
1977	53	46	46	54	64	54	53
1978	46	21	42	54	78	60	31

TABLE 2

Analysis of the Number of Half-Day Periods available for spoon gassing along a woodland periphery by an Operator who bases his decisions on Met. Forecasts.

CARDINGTON 1971-78

1) Critical wind value of ≤16 knots (Day length shown in brackets)

	JANUARY (0900-1600)				FEBRUARY (0800-1700)			
	1st-15th		16th-31st		1st-14th		15th-28(9th)	
YEAR	am	pm	am	pm	am	pm	am	pm
1971	12	12	11	8	11	11	14	10
1972	12	9	10	10	12	7	14	10
1973	13	13	15	14	10	11	12	11
1974	9	8	12	9	6	7	14	14
1975	9	8	7	7	14	10	13	12
1976	3	2	6	4	9	6	13	12
1977	11	11	13	13	8	6	10	9
1978	7	8	4	2	5	4	7	7

	MARCH (0700-1800)				APRIL (0600-1900)			
	1st-15th		16th-31st		1st-15th		16th-30th	
YEAR	am	pm	am	pm	am	pm	am	pm
1971	12	13	12	10	15	15	13	12
1972	12	9	13	11	6	7	12	12
1973	14	11	16	15	11	11	14	11
1974	13	15	16	16	15	15	14	14
1975	12	8	11	11	9	10	15	13
1976	15	9	6	8	11	10	12	7
1977	10	7	10	10	10	10	7	6
1978	11	9	4	4	9	6	12	12

	OCTOBER (0700-1700)				NOVEMBER (0800-1600)				DECEMBER (0700-1700)			
	1st-15th		16th-31st		1st-15th		16th-30th		1st-15th		16th-31st	
YEAR	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm
1971	12	13	11	12	14	11	11	12	15	15	14	12
1972	15	13	16	14	14	10	14	12	9	11	16	16
1973	14	13	14	13	11	10	13	12	14	12	10	14
1974	13	10	15	11	11	12	10	10	11	13	7	8
1975	12	10	16	12	13	10	9	8	12	13	12	8
1976	8	5	13	10	14	10	11	9	12	11	11	13
1977	13	8	13	12	5	2	9	10	13	12	12	12
1978	14	12	14	13	12	11	7	7	7	7	11	8

TABLE 2 (continued)

(ii) **Critical wind value of ≤20 Knots (Day length shown in brackets)**

YEAR	JANUARY (0900-1600)				FEBRUARY (0800-1700)			
	1st-15th		16th-31st		1st-14th		15th-28(9th)	
	am	pm	am	pm	am	pm	am	pm
1971	12	13	11	9	12	12	14	11
1972	12	9	11	11	12	7	14	10
1973	13	13	15	14	11	12	13	12
1974	11	10	13	13	8	8	14	14
1975	12	12	9	9	14	10	14	12
1976	8	8	7	6	10	10	13	13
1977	12	11	14	14	9	8	11	9
1978	9	10	6	5	5	6	10	9

YEAR	MARCH (0700-1800)				APRIL (0600-1900)			
	1st-15th		16th-31st		1st-15th		16th-30th	
	am	pm	am	pm	am	pm	am	pm
1971	13	13	14	14	15	15	13	13
1972	13	10	13	14	9	10	14	13
1973	14	13	16	15	13	15	14	12
1974	13	15	16	16	15	15	14	14
1975	12	8	12	14	11	12	15	15
1976	15	13	11	9	14	14	14	12
1977	12	8	13	11	12	13	8	10
1978	13	11	10	6	13	10	13	12

YEAR	OCTOBER (0700-1700)				NOVEMBER (0800-1600)				DECEMBER (0700-1700)			
	1st-15th		16th-31st		1st-15th		16th-30th		1st-15th		16th-31st	
	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm
1971	13	13	12	13	14	13	11	14	15	15	15	14
1972	15	13	16	15	15	11	15	13	12	11	16	16
1973	14	13	14	13	14	14	14	13	14	14	10	14
1974	13	10	16	13	11	12	11	11	14	14	10	13
1975	14	13	16	13	13	14	11	10	15	13	15	13
1976	11	8	13	11	14	10	12	10	13	12	11	14
1977	13	10	14	14	7	6	11	12	14	12	13	13
1978	15	13	16	14	13	13	11	10	10	12	12	9

TABLE 3

Number of Half-Day Periods available for Spoon Gassing along a woodland Periphery by an Operator who does not base his decision on a Met. Forecast.

CARDINGTON 1971-78

i) Critical wind value $\leqslant$16 Knots (Day length shown in brackets)

	JANUARY (0900-1600)				FEBRUARY (0800-1700)			
	1st-15th		16th-31st		1st-14th		15th-28(9th)	
YEAR	am	pm	am	pm	am	pm	am	pm
1971	11	13	10	11	13	11	13	11
1972	10	14	7	9	12	11	14	13
1973	12	14	15	14	10	9	13	13
1974	10	10	13	10	9	5	14	13
1975	13	12	10	9	14	13	14	13
1976	12	8	9	7	11	9	12	15
1977	15	14	16	14	8	8	10	11
1978	11	7	7	7	6	6	11	12

	MARCH (0700-1800)				APRIL (0600-1900)			
	1st-15th		16th-31st		1st-15th		16th-30th	
YEAR	am	pm	am	pm	am	pm	am	pm
1971	9	13	12	12	15	15	15	13
1972	11	10	13	11	5	7	11	11
1973	15	14	16	15	11	10	14	13
1974	13	15	16	13	15	14	14	14
1975	12	11	12	12	12	12	15	14
1976	15	13	10	9	14	13	13	13
1977	13	12	13	11	11	12	10	6
1978	10	11	11	5	13	12	12	14

	OCTOBER (0700-1700)				NOVEMBER (0800-1600)				DECEMBER (0700-1700)			
	1st-15th		16th-31st		1st-15th		16th-30th		1st-15th		16th-31st	
YEAR	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm
1971	14	12	11	10	14	10	11	12	15	15	12	12
1972	15	14	15	15	13	13	13	13	11	10	14	16
1973	14	14	14	14	11	11	13	13	13	12	12	14
1974	13	13	13	13	13	11	8	10	11	13	10	8
1975	14	15	16	16	13	13	13	12	15	13	15	14
1976	10	7	13	13	12	11	12	12	14	14	11	14
1977	13	12	14	15	11	6	12	14	13	13	12	12
1978	15	14	16	15	14	12	11	8	11	12	10	11

TABLE 3 (continued)

ii) Critical wind value of ≤ 20 Knots (Day length shown in brackets)

	JANUARY (0900-1600)				FEBRUARY (0800-1700)			
	1st-15th		16th-31st		1st-14th		15th-28(9th)	
YEAR	am	pm	am	pm	am	pm	am	pm
1971	12	13	10	11	14	13	13	12
1972	10	14	8	10	12	11	14	15
1973	12	14	15	15	11	11	13	13
1974	12	12	15	15	11	8	14	13
1975	14	15	10	10	14	13	14	13
1976	15	12	13	10	11	9	12	15
1977	15	15	16	15	9	11	12	12
1978	13	9	8	9	6	6	13	13

	MARCH (0700-1800)				APRIL (0600-1900)			
	1st-15th		16th-31st		1st-15th		16th-30th	
YEAR	am	pm	am	pm	am	pm	am	pm
1971	9	13	13	14	15	15	15	14
1972	13	11	14	12	10	9	12	13
1973	15	14	16	15	12	11	14	14
1974	13	15	16	15	15	14	14	14
1975	12	11	12	13	12	13	15	14
1976	15	15	13	11	15	14	15	15
1977	14	12	13	13	13	14	12	10
1978	12	13	15	11	13	13	12	14

	OCTOBER (0700-1700)				NOVEMBER (0800-1600)				DECEMBER (0700-1700)			
	1st-15th		16th-31st		1st-15th		16th-30th		1st-15th		16th-31st	
YEAR	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm
1971	14	12	12	13	14	14	12	12	15	15	14	13
1972	15	14	15	16	13	14	13	14	13	11	14	16
1973	14	15	14	14	12	14	14	15	13	14	13	14
1974	13	13	14	15	13	13	9	12	12	14	13	11
1975	15	15	16	16	13	14	13	13	15	13	15	15
1976	11	11	13	13	12	12	12	12	15	15	11	14
1977	14	13	14	16	13	11	15	15	13	13	12	14
1978	15	15	16	16	14	13	14	13	12	13	11	11

TABLE 4

- the potential number of daylight hours during the month when work was possible within a woodland

CARDINGTON 1971-78

i) Actual Hours

Year	Jan	Feb	Mar	Apr	Oct	Nov	Dec
1971	254	278	368	410	313	260	226
1972	256	284	366	409	325	264	224
1973	260	275	369	408	325	266	224
1974	252	267	364	413	317	253	227
1975	250	273	357	414	327	263	226
1976	258	287	369	418	320	254	222
1977	259	264	362	412	326	260	222
1978	250	273	361	411	329	264	217

ii) Percentage of max. possible

Year	Jan	Feb	Mar	Apr	Oct	Nov	Dec
1971	100	100	100	99	93	97	93
1972	100	100	100	99	97	99	93
1973	100	100	100	99	97	100	93
1974	99	97	99	100	95	95	94
1975	98	100	98	100	98	99	94
1976	100	100	100	100	96	95	92
1977	100	96	99	100	97	97	92
1978	98	100	99	99	98	99	90

FIGURE 1A

CARDINGTON 1971-78

CUMULATIVE FREQUENCIES OF THE NUMBER OF DAYLIGHT WORKING HOURS IN OPEN GROUND FOR CARDINGTON (1971-78)

OCTOBER

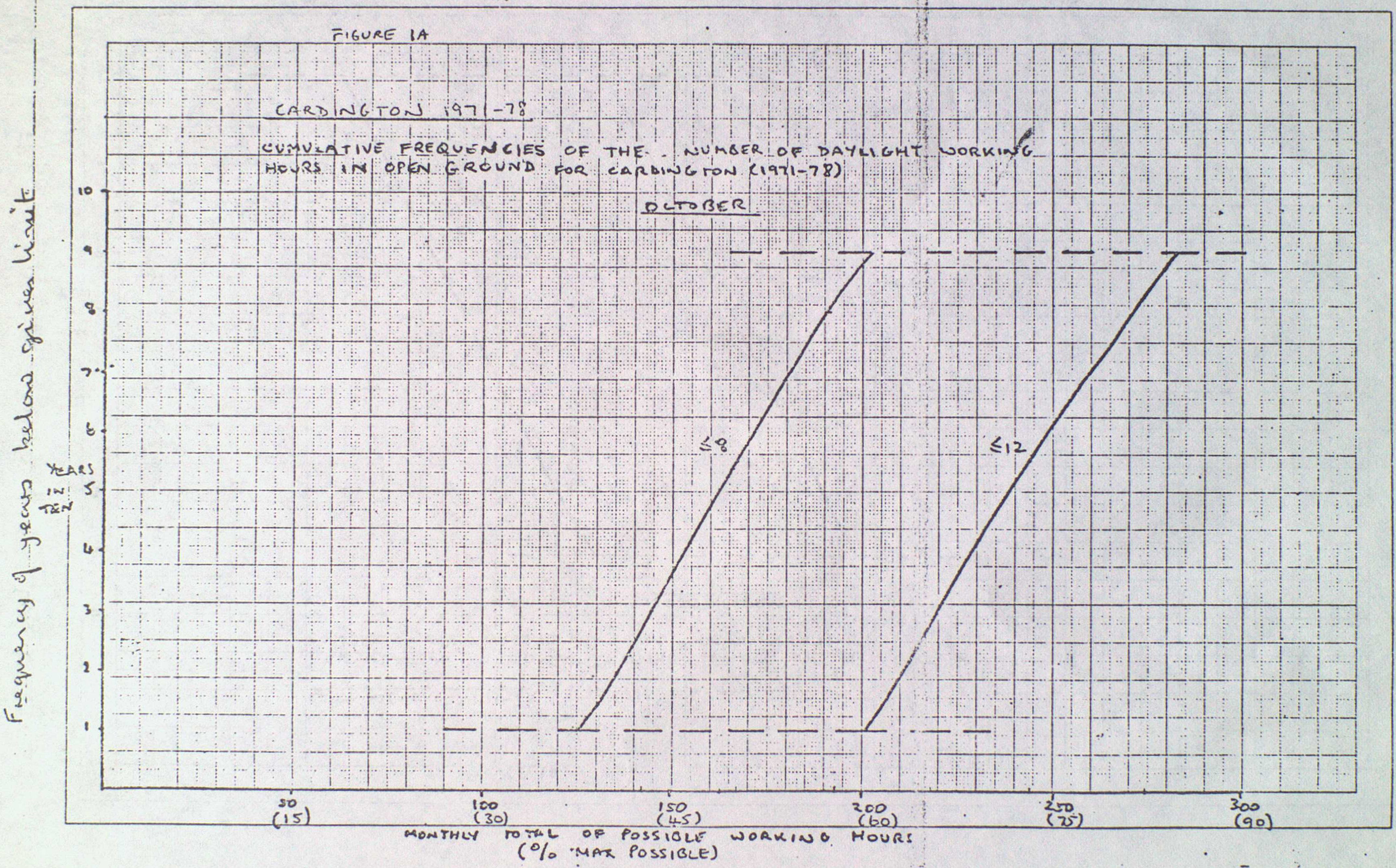
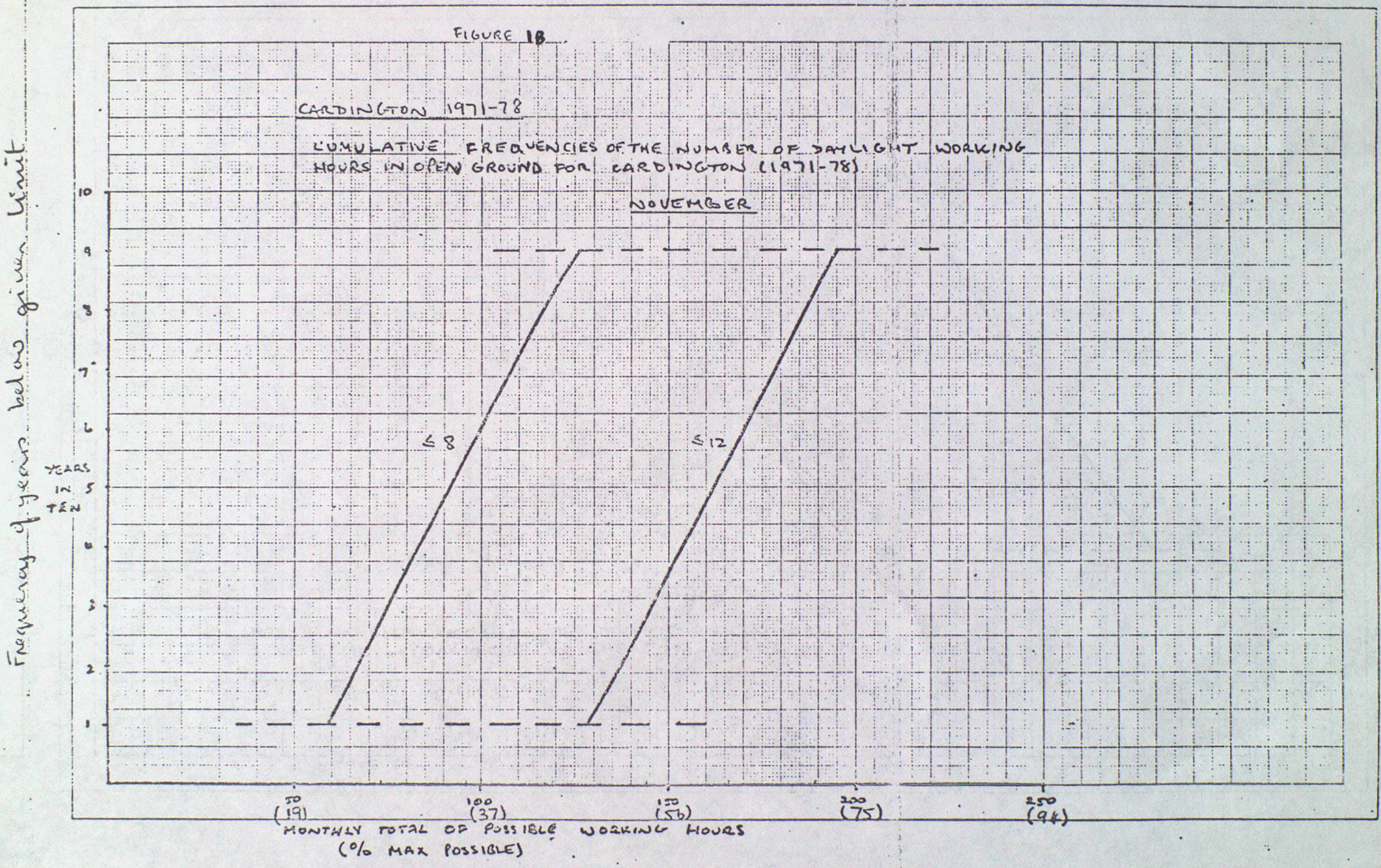


FIGURE 1B



CARDINGTON 1971-78

CUMULATIVE FREQUENCIES OF THE NUMBER OF DAYLIGHT WORKING HOURS IN OPEN GROUND FOR CARDINGTON (1971-78)

NOVEMBER

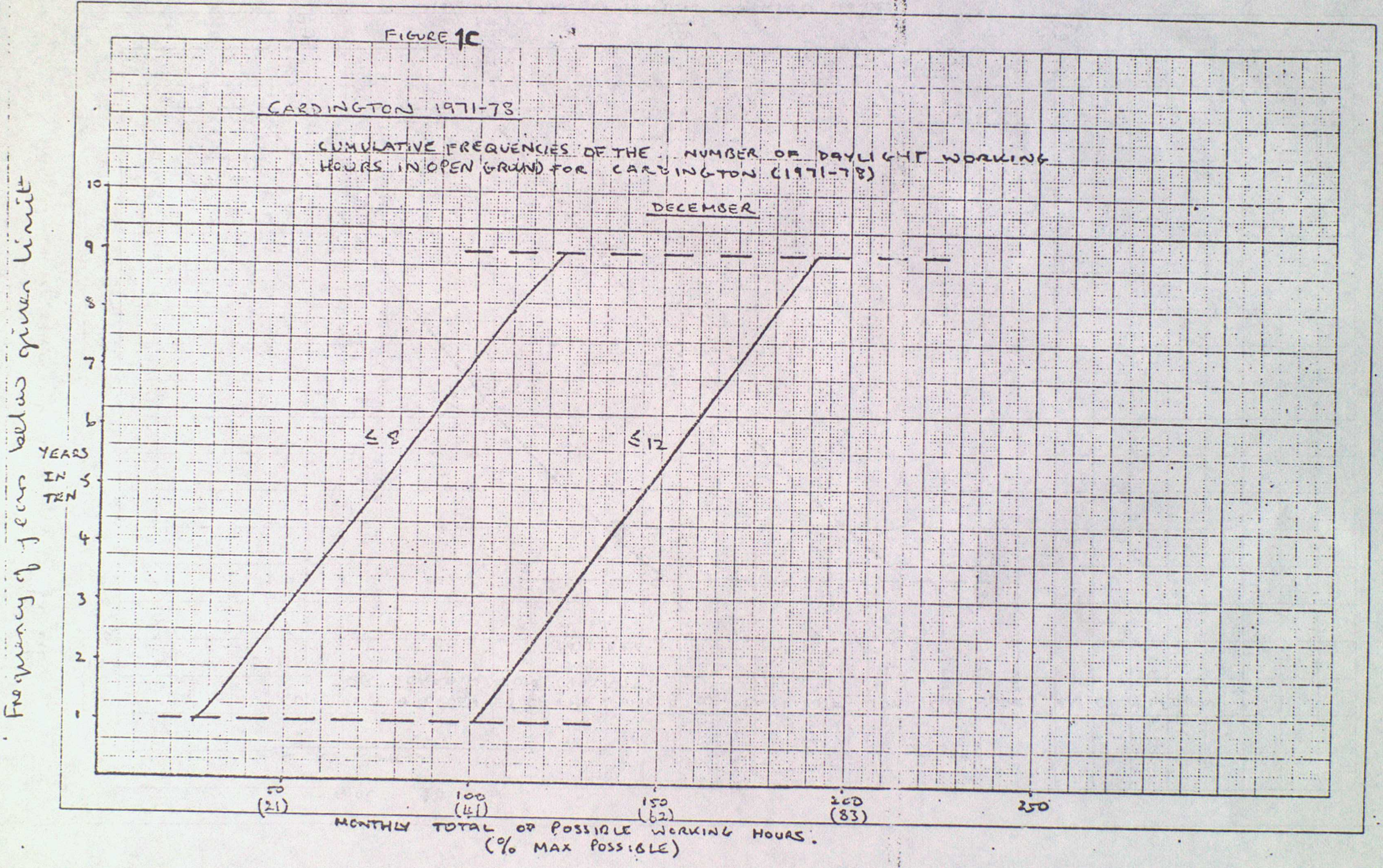


FIGURE 1C

CARDINGTON 1971-78

CUMULATIVE FREQUENCIES OF THE NUMBER OF DAYLIGHT WORKING HOURS IN OPEN GROUND FOR CARDINGTON (1971-78)

DECEMBER

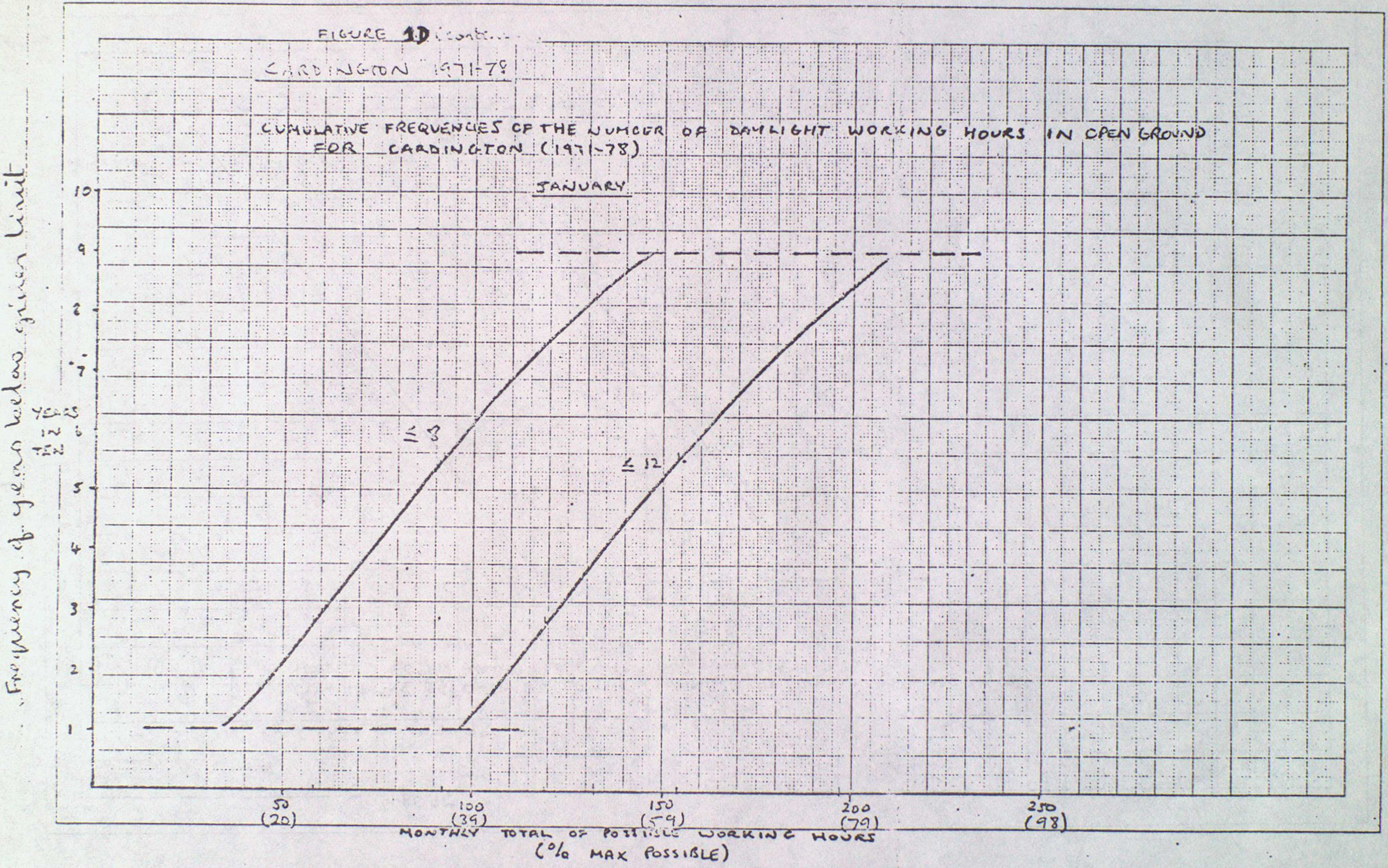


FIGURE 1D (cont...)

CARDINGTON 1971-78

CUMULATIVE FREQUENCIES OF THE NUMBER OF DAYLIGHT WORKING HOURS IN OPEN GROUND FOR CARDINGTON (1971-78)

JANUARY

Frequency of years below given limit

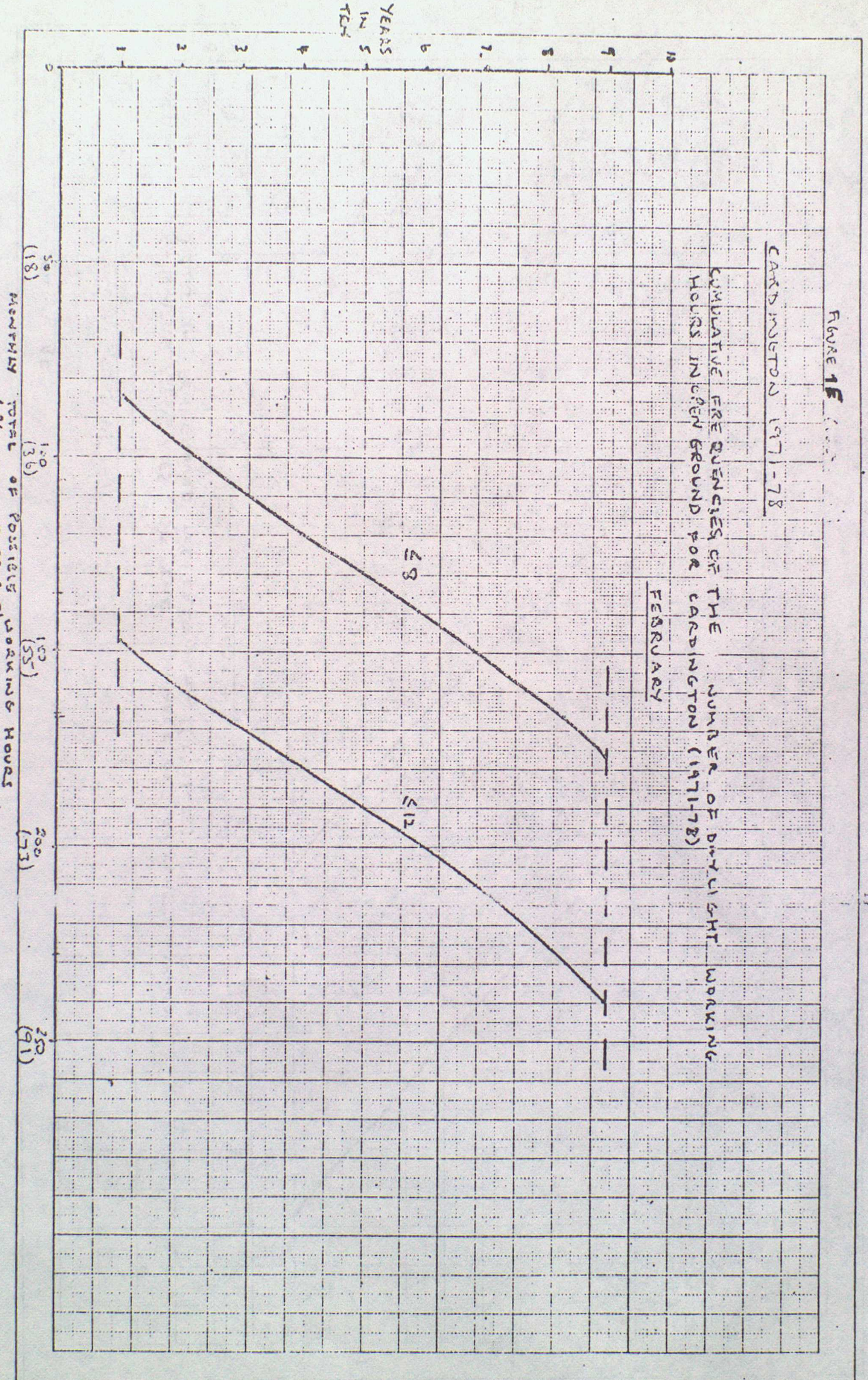


FIGURE 1F

CARDINGTON 1971-78

CUMULATIVE FREQUENCIES OF THE NUMBER OF DAYLIGHT WORKING HOURS IN OPEN GROUND FOR CARDINGTON (1971-78)

FEBRUARY

Frequency of years below given limit

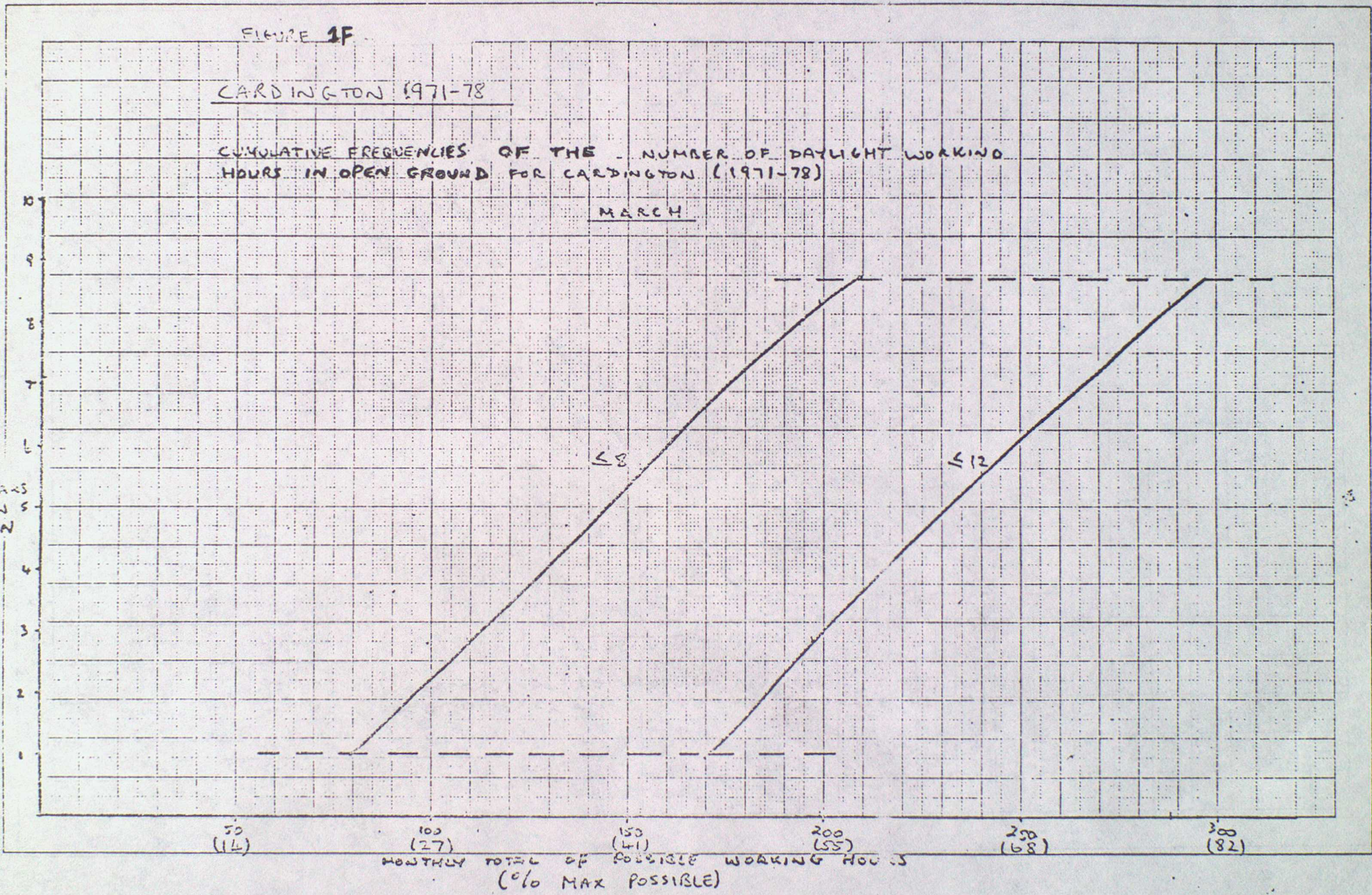


FIGURE 1F

CARDINGTON 1971-78

CUMULATIVE FREQUENCIES OF THE NUMBER OF DAYLIGHT WORKING HOURS IN OPEN GROUND FOR CARDINGTON (1971-78)

MARCH

FIGURE 1G

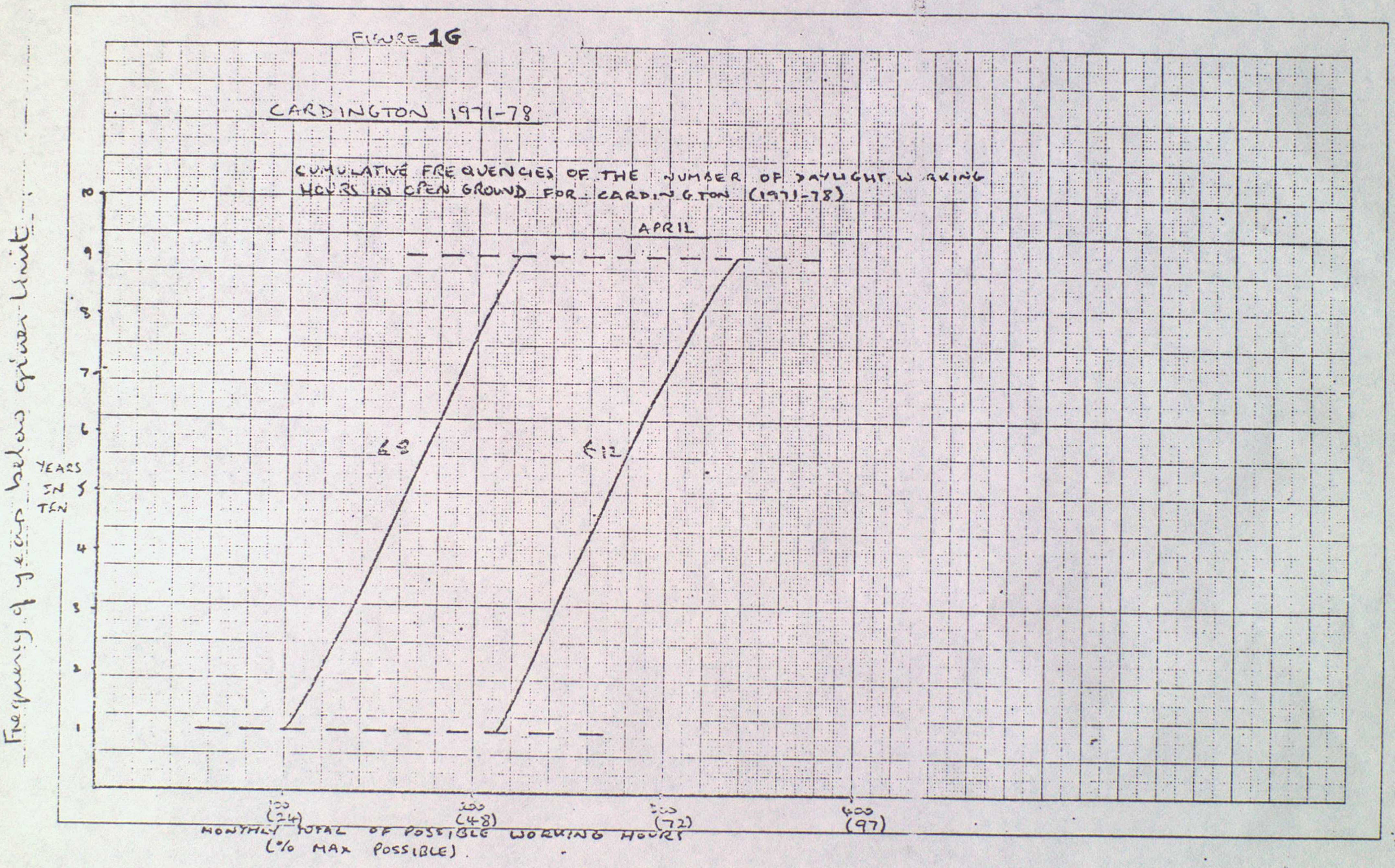
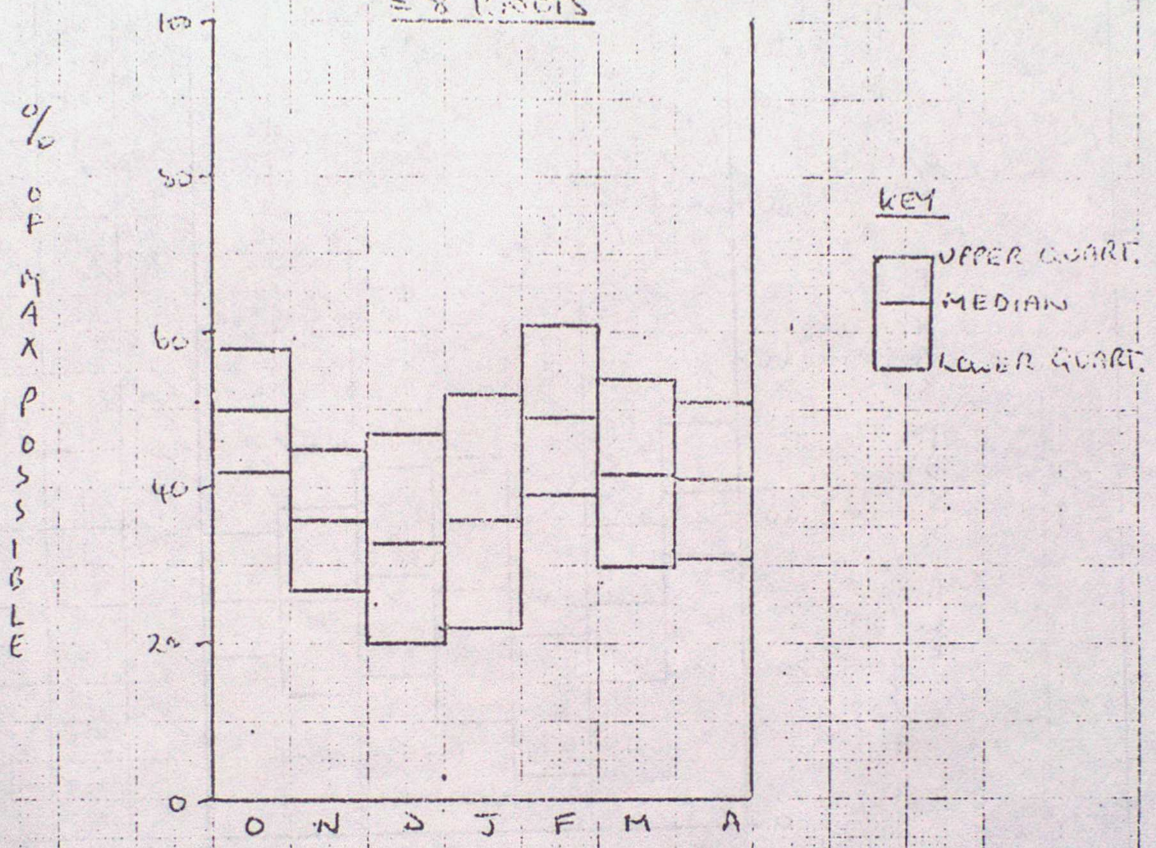

CARDINGTON 1971-78
CUMULATIVE FREQUENCIES OF THE NUMBER OF DAYLIGHT WORKING HOURS IN OPEN GROUND FOR CARDINGTON (1971-78)
APRIL
Frequency of years below given limit
YEARS IN TEN
10
9
8
7
6
5
4
3
2
1
≤8
≤12
100 (24)
200 (48)
300 (72)
400 (97)
MONTHLY TOTAL OF POSSIBLE WORKING HOURS
(% MAX POSSIBLE)

FIGURE 2A

POTENTIAL TIME AVAILABLE FOR SPOON GASSING RABBITS IN AN AREA OF RELATIVELY OPEN GROUND (EXPRESSED AS A PERCENTAGE OF THE MAX POSSIBLE)

1) CARBURTON 1971-78

≤8 KNOTS



≤12 KNOTS

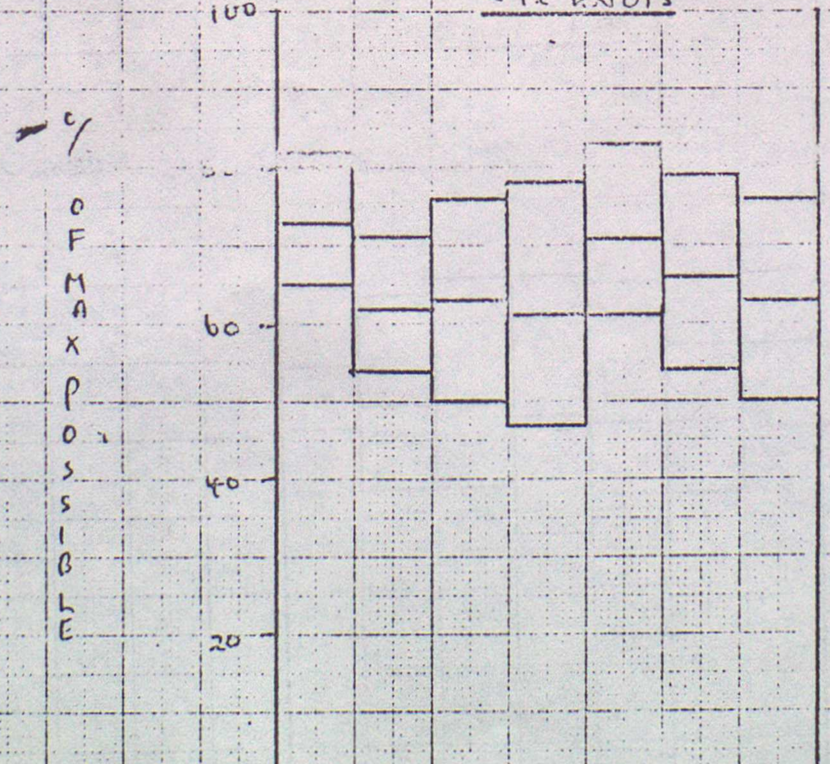
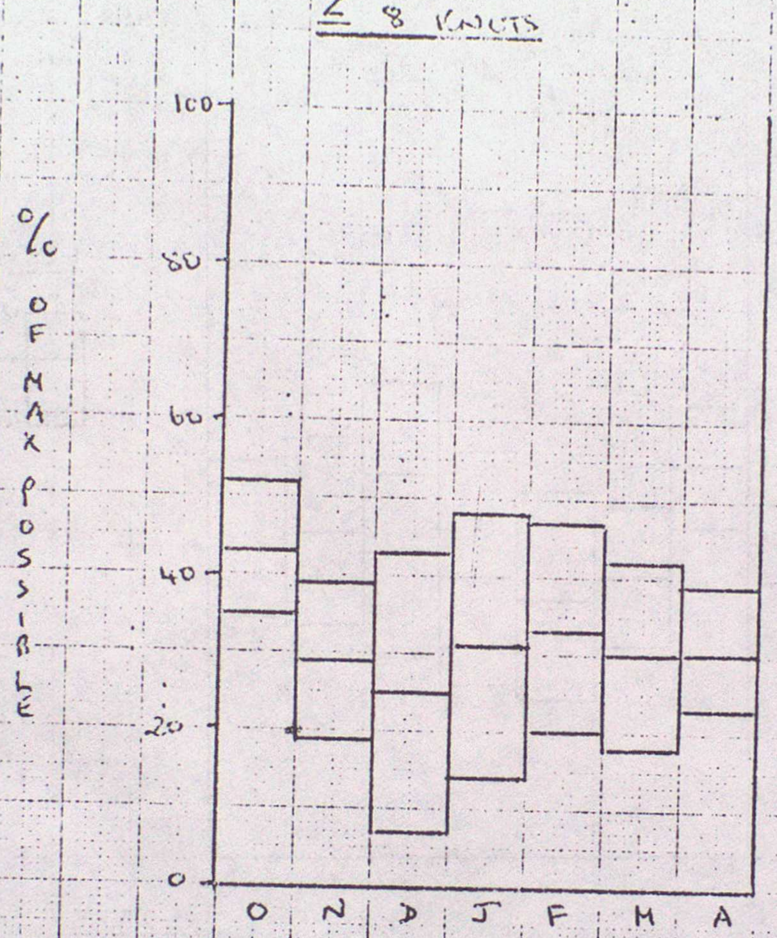


FIGURE 2B

2) HONINGTON 1969-78



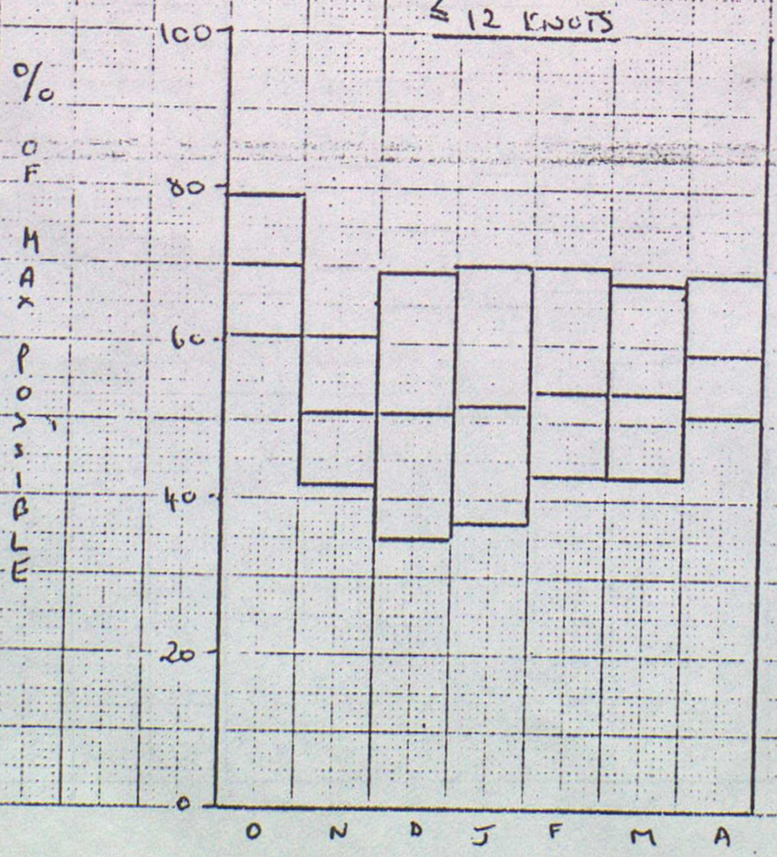
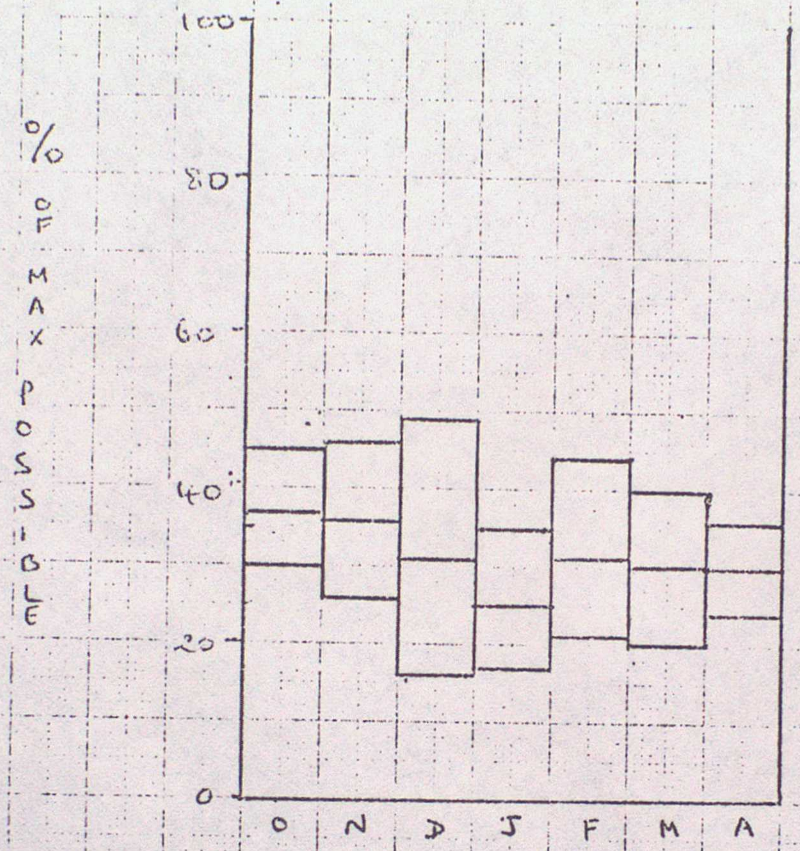


FIGURE 2C

3) BOSCOMBE DOWN 1969-78

≤ 8 KNOTS



≤ 12 KNOTS

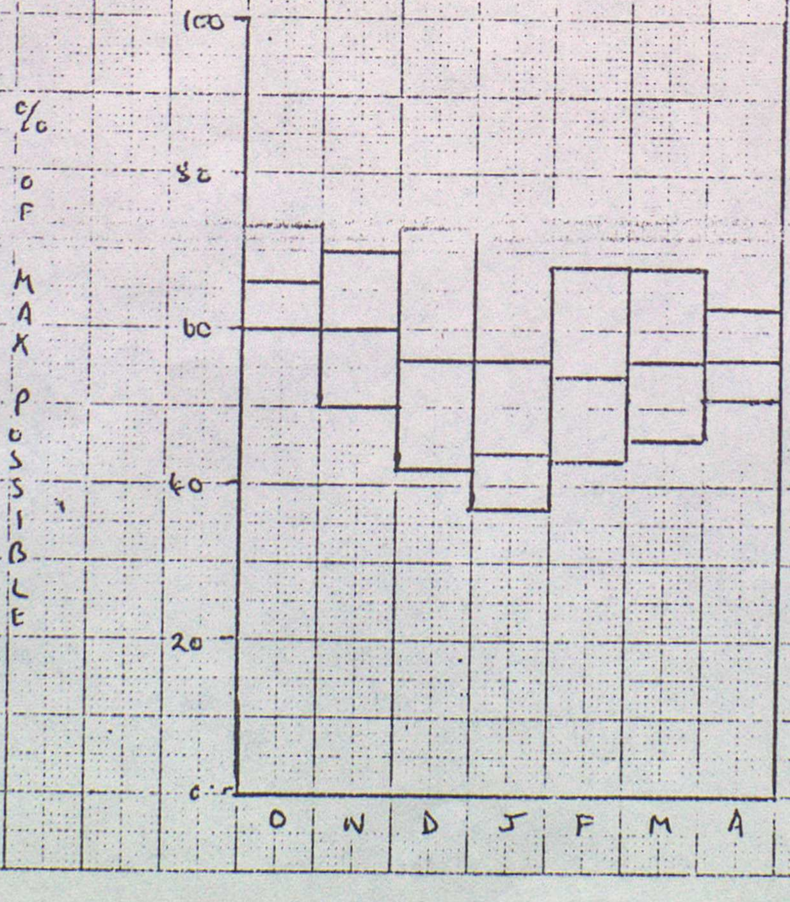
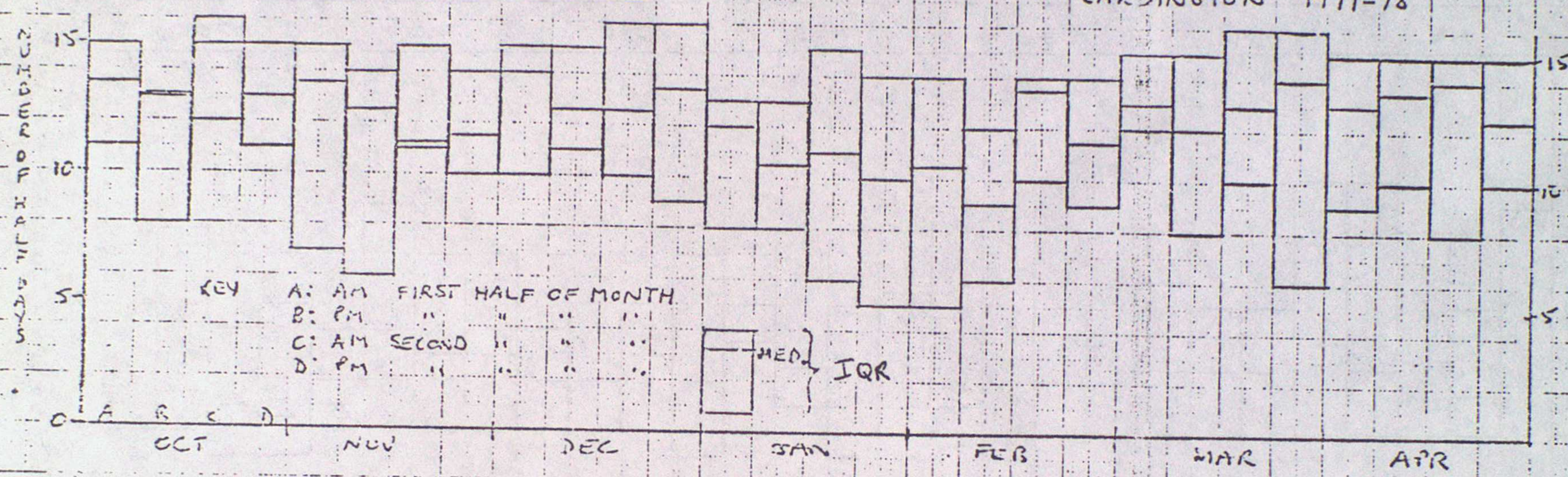


FIGURE 3

HALF DAY PERIODS AVAILABLE FOR SPOON GASSING ALONG A WOODLAND PERIPHER TO AN OPERATOR WHO USES MET FORECASTS

1) CRITICAL WIND SPEED ≤20 KNOTS



2) CRITICAL WIND SPEED ≤16 KNOTS

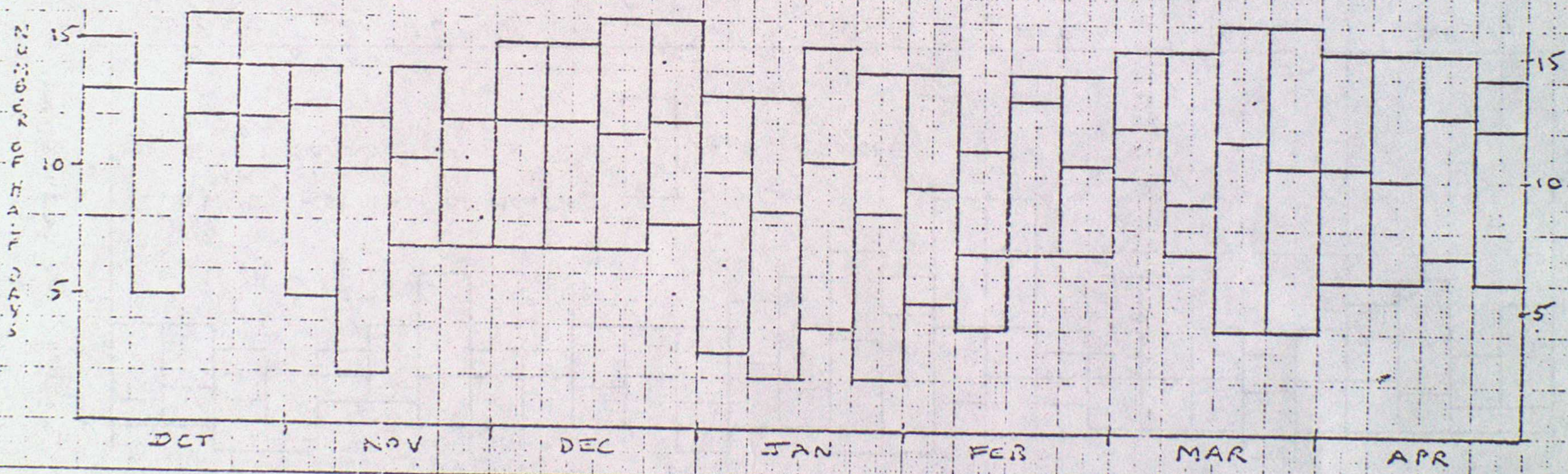
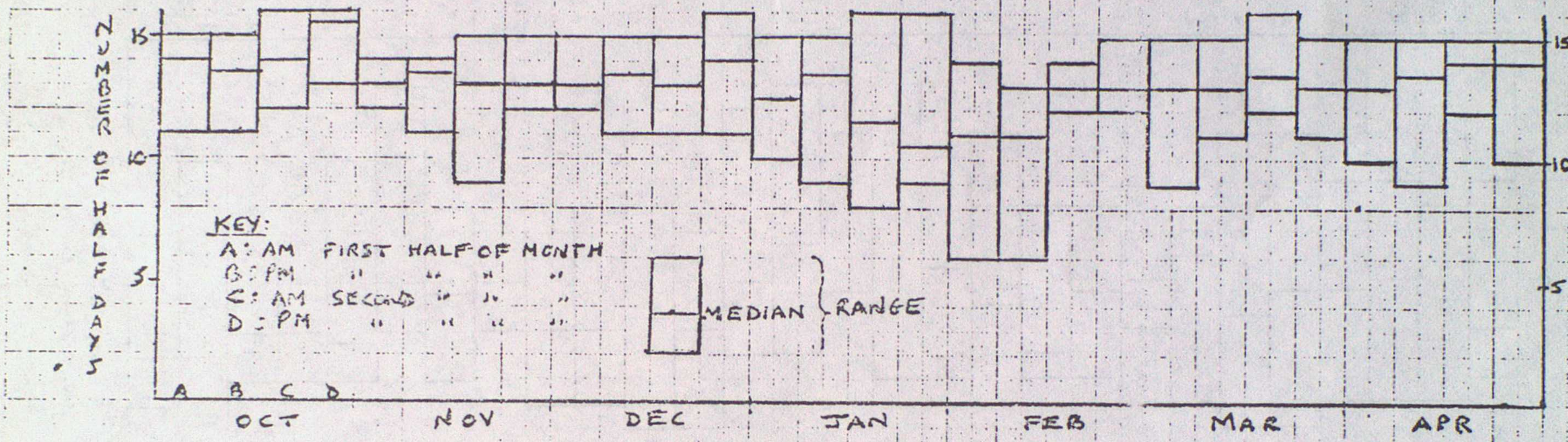


FIGURE 4

HALF DAY PERIODS AVAILABLE FOR SPOON CASSING ALONG A WOODLAND PERIPHERY TO AN OPERATOR WHO DOES NOT USE MET FORECASTS

1) CRITICAL WIND SPEED ≤20 KNOTS

CARDINGTON 1971-78



2) CRITICAL WIND SPEED ≤16 KNOTS.